Space Magnets Attracting Interest on Earth

Applications of Physical and Biological Techniques in the Study of Gravisensing and Response System of Plants

The BioTube/Magnetic Field Apparatus (MFA) research is designed to provide insight into the organization and operation of the gravity sensing systems of plants and other small organisms. This experiment on STS-107 will determine if magnetic fields can stimulate sensory cells in plant roots, thus using magnetic fields as a substitute for gravity. The experiment will be located in the SPACEHAB Module and is about the size of a household microwave oven.

Figure 1: Flax root growing in Magnetic Field Chamber hardware.

Earth Benefits and Applications

The goal of the experiment is to improve our understanding of the basic phenomenon of how plants respond to gravity and magnetic forces. The BioTube/MFA experiment specifically examines whether magnetic fields can replace gravitational forces as a directional signal for growth in the low gravity environment of space. This research may ultimately be expanded to include studying the effects of magnetic fields on other living systems. Magnetic fields could ultimately take the place of gravity for plants in space. As with all basic research this stury will contribute to an improved understanding of how plants grow and will have important implications for improving plant growth and production on Earth.

BioTube/Magnetic Field Experiment

In BioTube/MFA, magnetic fields will be used to determine whether amyloplast distribution within plant cells predicts the direction in which roots will grow and curve in microgravity.

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Figure2: BIOTUBE/ MFA in locker

On Earth, starch grains called "amyloplasts" in plant cells accumulate in the direction of gravity causing a change in the cell. This essentially translates to a signal indicating which direction is "up" or "down". The BioTube/MFA experiment utilizes high-gradient magnetic fields to change the distribution of amyloplasts in flax roots. The magnetic field is concentrated at a specific point which produces magnetic gradient. As the root approaches the wedge, it moves into the magnetic gradient. The starch grains are then repelled by the magnetic gradient, causing the roots to curve in the direction of the displaced starch grains.

The BioTube/MFA experiment contains dry flax seeds (also known as Linum usitatissimum) that will germinate in space. The seeds will absorb the water and the roots will begin to grow across the high-gradient magnetic field wedges in two Magnetic Field Chambers. A third Magnetic Field Chamber will provide a constant magnetic field for the roots as a comparison to the high-gradient magnetic field. Time-lapse imagery will record pictures of the roots. Approximately forty-eight hours after seed watering, a chemical fixative will preserve the flax specimens for microscopic analysis and the experiment will end.

BioTube/Magnetic Field Experiment

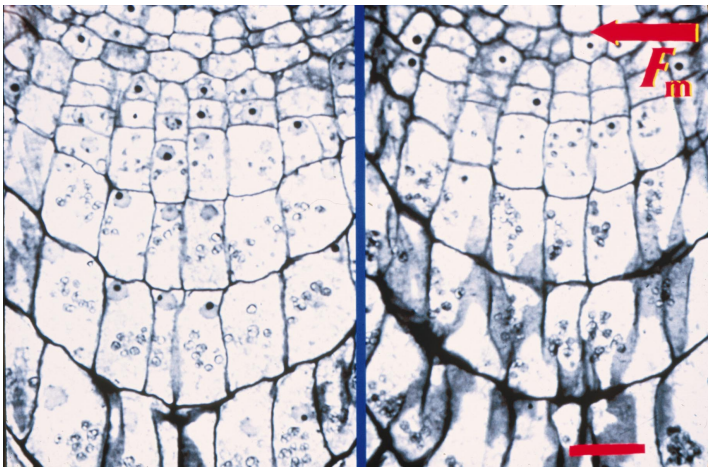
The science objectives of the BIOTUBE/MFA experiment address three major questions:

1) Are amyloplasts the organelles in plant cells that perceive gravity?

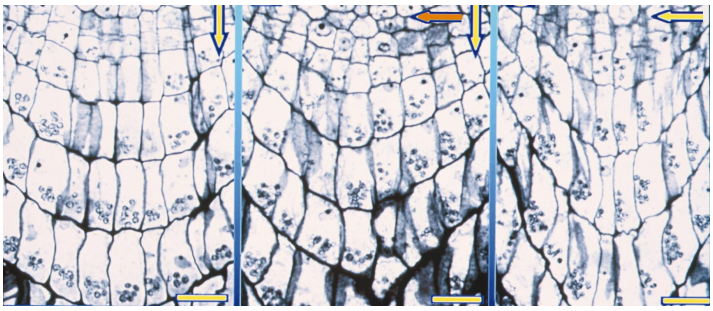
2) Does the position or movement of the amyloplasts (sedimentation on earth, or, response to a high gradient magnetic field in orbit) affect the root growth direction?

3) Does gravity exert an effect on the deposition of cell wall material and the organization of plant cells organelles?

These goals will provide insight into the fundamental organization and operation of the gravity response system of plants and determine if other areas need directional cues for directional growth in addition to the plant's sensory cells.



The left panel depicts the random orientation of amyloplasts in clinorotated controls. The right panel shows the superposition of a ponderomotive magnetic force displacing amyloplasts to the left.



The left panel belongs to a normal root with the amyloplasts sedimented to the apical region. The center panel shows a root cap with a lateral high-gradient magnetic field displacing amyloplasts to the left. The right panel shows a gravistimulated root with amyloplasts sedimented to the left.

Astronaut Participation

Astronauts will turn on the BioTube/MFA experiment three days prior to landing. All experiment operations will be complete within a forty-eight hour period. The BioTube/MFA software automatically controls a series of events that will deliver water to the seeds, take images of the growing roots and deliver a chemical fixative which preserves the roots for later analysis. The astronaut crew will periodically check on the equipment as the experiment progresses and will turn the power off following chemical fixation.

Science Discipline Supported

The BioTube/MFA research primarily addresses Fundamental and Space Biology, but applies to other disciplines.

For more information about NASA's Fundamental and Space Biology programs, please refer to the following Internet web site:

http://www.fundamentalbiology.arc.nasa.gov

Future Similar Experiments on International Space Station

Similar flight experiments could be conducted on the International Space Station to increase the knowledge of how biological processes are affected by microgravity. The use of magnets in place of gravity will have important implications for long-term spaceflights where crews may depend on plants for food, oxygen, and water.

For more information about NASA's International Space Station program, please refer to the following Internet web site:

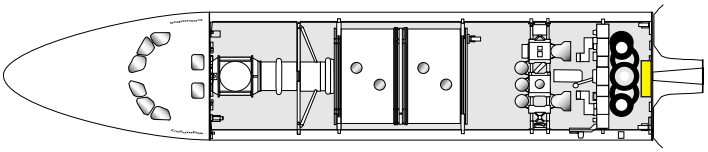
http://spaceflight.nasa.gov/station/index.html

Further Information:

For further information about the BioTube/MFA experiment and other spaceflight experiments, please refer to the following Internet web sites:

http://lsda.ksc.nasa.gov/payload/KSC_web.html
http://www.ksc.nasa.gov
http://lsda.jsc.nasa.gov

Show yellow dot depicting payload on the aft wall of the SPACEHAB module— — — — —I don't know aft walls-need help in this area, Melissa.



Approximate location of this payload aboard STS-107.